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$$
\begin{aligned}
da &= -6''\!.47 \\
d\delta - d\Delta &= +1.21 \\
dS &= -1.68 \\
ds &= -0.49
\end{aligned}
$$

From meridian observations on Dec. 20, 23, 24, 28, 29, the Sun's tabular error was found:—

In R.A. $= +0^s.11$
In N.P.D. $= +2''.2$

Combining this result with that given above, we obtain as the tabular error of the Moon:—

In R.A. $= +0^s.54$
In N.P.D. $= +1''.0$

The effect of these corrections on the choice of stations for observing the totality appears to be very small. The central line would be shifted nearly 5 miles further south, and the breadth of the shadow increased by about double that amount, whilst the time of first contact would be accelerated and of last contact retarded by about 10^s.

The altazimuth observations give error of tabular altazimuth:—

Of Moon's 2 L.	$= -11''.00$	from	6 Obs.
,, 1 L.	$= -3.83$	,,	12 ,,

Whence error of Tab. Geoc. Semidiam. $= + 3''.48$.

Applying this as a correction to the semidiameter used in the reduction of the observations of Z.D. of Moon's U.L. we find tabular error of Moon:—

In R.A. $= +0^s.54$
In N.P.D. $= +2''.54$

As from altazimuth observations of the *bright* Moon the error of semidiameter in azimuth $= -0''.5$, the eclipse observations give for the sum of irradiations of Sun and Moon with the altazimuth $4''.0$ for an object-glass of $3\frac{3}{4}$-inches.

With the Great Equatoreal (aperture $12\frac{3}{4}$-inches) the value appears to be about $0''.5$.

The Solar Eclipse, Dec. 22, 1870. By the Rev. S. J. Perry.

(*Communicated by W. H. H. Hudson, Esq.*)

A mere glance at the published results of the late Eclipse Expeditions will be sufficient to convince any one, who is at all conversant with the subject, of the great advance that has just been made in our knowledge of solar physics. That so much should have been accomplished, when the obstacles to success

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seemed to meet the observers at every turn, is a matter of no little surprise, and the value of the observations already published is an earnest of what we are to expect from a careful discussion and arrangement of the collective results.

No one will doubt but that much good work has been done during the two short minutes of totality by the polariscope and spectroscope, by the telescope and eye observations, and by photography, and it would be a matter of no small difficulty to determine at present the relative merits of these several aids to our observers. We shall therefore form a fair idea of what has been effected by the various modes of observation, if we pass in rapid review the triumphs of a single one. Let us take spectroscopy, for instance.

Passing over the accurate determination of the time of first contact, of which a warning of 15^s was given by Prof. Young, from the observed gradual extinction of the bright lines of the chromosphere by the Moon's dark limb, we come to the observations that have a more direct bearing on solar physics.

If we start from the photosphere in an outward journey, we find at the outset that the observations of Prof. Young and Mr. Pye of London have satisfactorily closed a discussion which has occupied so many pages of the *Comptes Rendus*, the *Philosophical Magazine*, and other publications during the last twelve months, as to the existence of a thin absorption shell dividing the photosphere from the chromosphere. What had so far been invisible to our English spectroscopists, but what Secchi, favoured by a clear Roman atmosphere, had seen as a continuous spectrum, burst forth during the eclipse as an innumerable mass of bright lines apparently identical in position with the dark absorption lines of the solar spectrum. This glorious sight lasted but for one or two seconds, being visible only when the stronger light of the photosphere was eclipsed, and eclipsed itself in turn by the dark Moon as soon as visible. This thin shell of vapours, scarce 1000 miles in thickness, possesses an importance far greater than its relative extent alone would justify, if we may look upon it as the seat of that selective absorption which gives existence to the dark Fraunhofer lines.

Continuing our outward journey we come next to the chromosphere, whose constitution and wondrous forms, and still more wondrous motions, are now a matter for daily study and observation, and therefore possess less of interest for the observer than those other spherical shells of vapour, which can only be examined during the fleeting moments of totality. The addition of some new faint line, or of the exact form of a few solar prominences, could scarcely add appreciably to the knowledge acquired by the labours of Lockyer, Young, Respighi, and others, and would not repay the loss of time so valuable for other researches.

But the outer layer of cooler hydrogen, whose tale has just been told by the spectroscope of Mr. Abbay, is more worthy of present attention. The bright lines 1474 and F were seen

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together; F less brilliant than 1474. Mr. Pye, by whom a similar observation was made of 1474, C, D_3, and F, estimated the relative brightness of the four lines, and found them to vary as the numbers 100, 85, 55, and 30. The observations of Denza and Carpmael, who both saw two lines in the corona, and those of Harkness, Barton, &c., will probably be found to confirm the above; and may, moreover, give the definite portion of the corona under observation, which Abbay and Pye could not do from the nature of their instruments.

Hydrogen, therefore, which gives a spectrum so much more bright than the green line 1474 when seen in chromosphere, must in the observations under discussion be far less heated, and becoming thus unable to send us in any strength its crimson light, shines mainly with a borrowed solar light. Hence the strong radial polarization; hence the silvery white of the leucosphere, or ring-formed inner corona, which I suppose must consist in great part of the cooler hydrogen, mixed of course with the green vapour of the line 1474. Burton's observation of the extension of the hydrogen lines also tends to strengthen this position, and to establish the reality of the cooler hydrogen envelope.

The absence of the dark Fraunhofer lines should be of little weight, considering the faintness of the spectrum.

But the argument from the varying brilliancy of the lines appears somewhat weakened by the observation of Capt. Maclear, who found the hydrogen lines everywhere,—in prominences, on corona, on dark Moon,—their varying brightness depending not on their internal heat, but on the mode of their reaching us, either as direct or dispersed rays. This strong dispersion of the chromospheric lines by cloud and atmosphere also renders any accurate determination of the limits of the several solar envelopes, by aid of the spectroscope, a matter of the greatest difficulty.

But whatever the exact extent of the inner shells of vapour, of the absorbing envelope, or chromosphere, or leucosphere, we come at last to a hollow sphere of vapour lighter than hydrogen, whose spectrum is the bright green 1474, whose internal diameter we may perhaps roughly guess at, but which outwardly stretches forth into space, probably far beyond any limits we are likely accurately to measure. Prof. Young followed this line, as it gradually diminished in brightness, from the photosphere to a distance of 16′ from the Moon's limb, whilst Winlock traced it to 20′; but the bright lines seen on the dark Moon tell us that the observed extent may in part be due to the dispersion from the atmosphere. The observations of Young and Winlock are confirmed by those of Burton, Harkness, Pye, Abbay, and others, thus leaving no room for us to doubt the existence of this vast sphere of vapours, which will probably enter largely into all future theories of the ether of space.

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